Bicycle Facilities Planning and Design Handbook

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Florida Department of Transportation
State Safety Office, MS 82
Pedestrian and Bicycle Program
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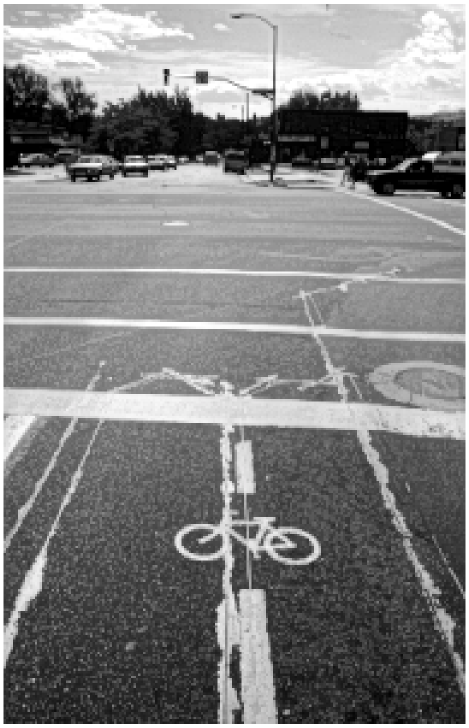
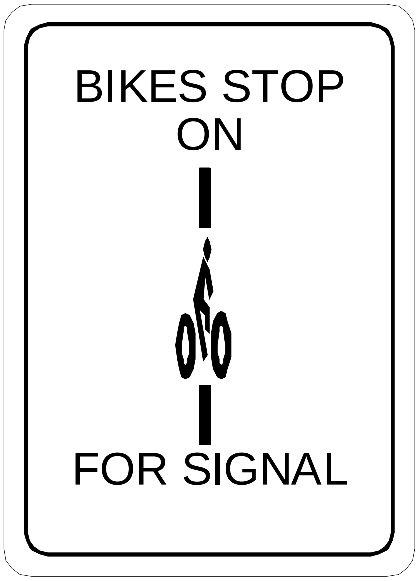


Loop Marking for Bicyclists. *Above: Signals should be engineered to gain the maximum compliance from bicyclists. This loop marking from Boulder, Colorado has been proposed for use in Florida. The symbol is placed to show bicyclist where to stop for maximum detection.*
Below: Proposed sign for use with symbol.



symbol and the sign are shown in the Appendix D.) This symbol would probably be used primarily on side streets crossing major arterials. These roadways frequently do not get a green light unless there is a detected vehicle. This is frequently a problem on weekend mornings when there is very little side street traffic and the signal is resting on the arterial. Protected-only left turn lanes are another location where this symbol would be useful.

This symbol has been used in Gainesville to mark a loop that had been installed within a bike lane.

4.6.3.3 Bicycle Actuated Signals

In some instances it may be desirable to place a traffic signal loop within the bicycle lane. If a loop is installed, bicyclists should be informed of the loop's presence by a pavement symbol and sign.

Advance loops have also been used in bike lanes. By placing the signal loops in advance of the intersection the signal can change prior to the cyclists' arrival. Trails may be another appropriate place for advance loops.

4.6.3.4 Special Signals for Bicyclists

Special signals and signal phases have been used for bicyclists. Where bicycle lane volumes are heavy, and on a case-by-case basis, the designer could consider a special phase signal for bicycle use only. This allows cyclists to cross the street and make turns without having to contend with motor-vehicle traffic. This approach solves the problem of intersection conflicts inherent in the mixing of users on a roadway.

4.6.4 Limited Access Intersections

Crossing the intersection terminal on freeway ramps poses special hazards to bicyclists due to speed of entry and exit, long tapers, and expansive roadway crossing widths. Bicyclists can be aided through several principles of design:

- Slow the speed of the bicyclist on final approach, and create a yield for the bicyclist.
- Create a right angle crossing and a reasonable viewing distance by separating the bicyclist with a jughandle pathway, and crossing the bicyclist at a point in the ramp where the motorist is attending to steering control as opposed to an over-the-shoulder gap assessment.

4.7 Roadway Treatments

Bicycle-safe design practices, as described in this handbook, should be followed to avoid the necessity for costly subsequent improvements. Because most highways have not been designed with bicycle travel in mind, there are often many things which can be done to improve the roadway for bicyclists. In addition, the desirability of adding facilities such as bicycle lanes, shoulder improvements, and wide curb lanes (the least preferred option) should be considered.

Roadway conditions should be examined and hazardous conditions removed. Information on several roadway improvements is contained in this section. The controlling feature of the design of every bicycle facility is its location (i.e., whether it is on the roadway or on an independent alignment).

4.7.1 Cross slopes

Paved shoulders are frequently designed with cross slopes of 6%. While this cross slope does not create difficulties for bicyclists, it is the maximum which should be used on bicycle facilities.

4.7.2 Lighting

On road bicycle facilities should be lit to the same levels as the roadways. The *Plans Preparation Manual* gives the following standards:

For major arterials:
Illumination level (Average initial lux) = 16
Uniformity ratio:
avg./min. 4:1 or less

max./min. 10:1 or less

For all other roadways:
Illumination level (Average initial lux) = 11
Uniformity ratio:
avg./min. 4:1 or less

max./min. 10:1 or less

4.7.3 Drainage Grates

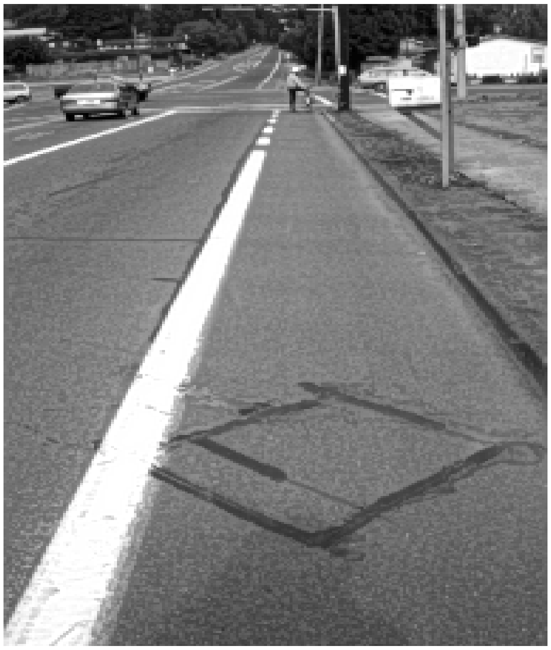
Drainage grate inlets and utility covers are potential problems to bicyclists. Typical drainage grates can be:

- slippery
- not flush with the road surface
- a prime location for debris and water, and
- capable of trapping bicycle wheels.

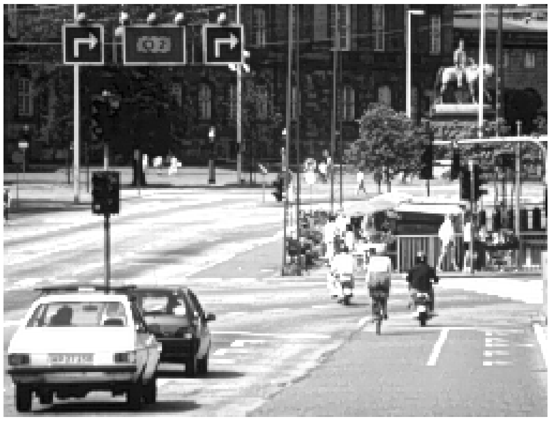
When a new roadway is designed, all such grates and covers should be kept out of bicyclists' expected path, or they should be designed to accommodate bicycle traffic, as described below.

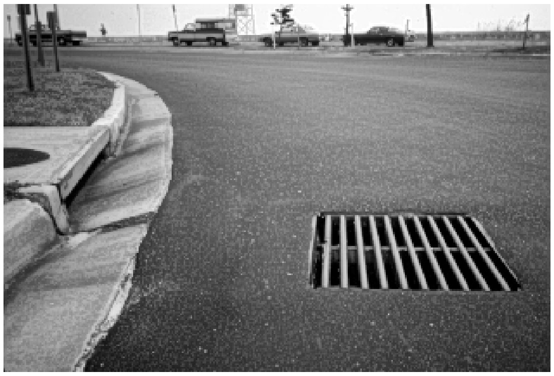
On roadways where bicyclists will be permitted, curb inlets should be used, wherever possible, to eliminate exposure of bicyclists to grate inlets. It is important that grates and utility covers be adjusted flush with the surface, including after a roadway is resurfaced.

The advance loop shown below is in Corvalis, Oregon.

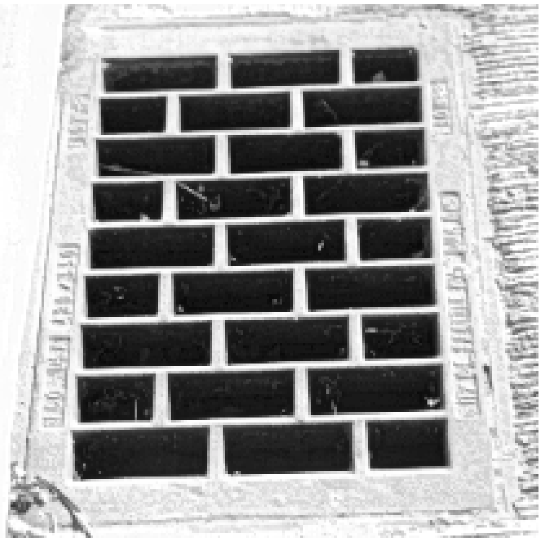


This specially marked lane in Copenhagen, Denmark illustrates a method used when bicycle and motor vehicle volumes are high. The bicyclists and motorists each have their own signal for right turns and through movements.





"Bicycle Parking Rack". *Keep these out of the roadway. The above inlet is hazardous. Use inlet grates following FDOT Standard Index 229. If roadway placement is necessary use "bike safe" grates as shown below. The grates shown for in-street use in the FDOT Standard Index sheets are also bicycle friendly.*



When older drainage facilities extend into the paved area, mark the hazard to steer bicyclists around them.

Parallel bar drainage grate inlets can trap the front wheel of a bicycle, resulting in loss of steering control and often serious damage to the bicycle wheel and frame and/or injury to the bicyclist. Grates with parallel slat designs that trap bicycle wheels are still used frequently in some roadway and many non-roadway environments, such as in parking lots, across driveways, and other hazardous locations. These grates should be replaced with bicycle-safe and hydraulically efficient ones. Designers must be vigilant always to specify bicycle safe inlet grate designs.

As a last and temporary resort, identifying a grate with a pavement marking would be acceptable in some situations. As indicated in the MUTCD, parallel bar grate inlets deserve special attention. Because of the serious consequences of a bicyclist missing the pavement marking in the dark or being forced over such a grate inlet by other traffic, these grates should be physically corrected, as described above, as soon as practicable, after they are identified.

4.7.4 Railroad Crossings

At highway grade crossings of railroads, the rails should ideally be at a right angle to the road. The greater the crossing deviates from this ideal angle, the greater is the potential for a bicyclist's front wheel to be trapped in the flangeway causing loss of steering control. It is also important that the roadway approach be at the same elevation as the rails.

Consideration should be given to the materials of the crossing surface and to the flangeway depth and width. If the crossing angle is less than approximately 45 degrees (crossing angles of 30 degrees or less are considered exceptionally hazardous), consideration should be given to widening the outside lane, paving the shoulder or providing a bulbed out bicycle lane to allow bicyclists adequate room to cross the tracks at a right angle. The approach and departure shoulder should be paved, and should provide sufficient length to allow the bicyclist to merge into a gap in traffic. This treatment is shown in the graphic on the left. Where this is not possible, commercially available compressible flangeway fillers can enhance bicyclist safety. In some cases, abandoned tracks can be removed. Warning signs and pavement markings should be installed in accordance with the MUTCD. Additional pavement markings directing the bicyclist toward the best crossing angle should be considered.

Ensure any crossing designs are approved by the state rail office and the appropriate railroad.

4.7.5 Pavements

Often the right-most portion of a highway deteriorates first in a highway cross section. Since this is the area of a roadway where bicyclists generally ride to stay out of traffic, it is imperative pavements be selected and constructed to provide long life. Pavement surface irregularities can do more than cause an unpleasant ride. Gaps between pavement slabs or drop-offs at overlays parallel to the direction of travel can trap a bicycle wheel and cause loss of control. Holes and bumps can cause bicyclists to swerve into the path of motor vehicle traffic. Thus, to the extent practicable, pavement surfaces should be free of irregularities and the edge of the pavement should be uniform in width. On older pavements it may be necessary to fill joints, adjust utility covers or, in extreme cases, overlay the pavement to make it suitable for bicycling.

4.7.6 Rumble Strips

Rumble strips can be a deterrent to bicycling on shoulders and their benefits should be weighed against the probability bicyclists will ride in the motor vehicle lanes to avoid them. As a general rule, rumble strips should only be used on curves, approaches to narrow bridges and other locations where there is a high potential for benefit.

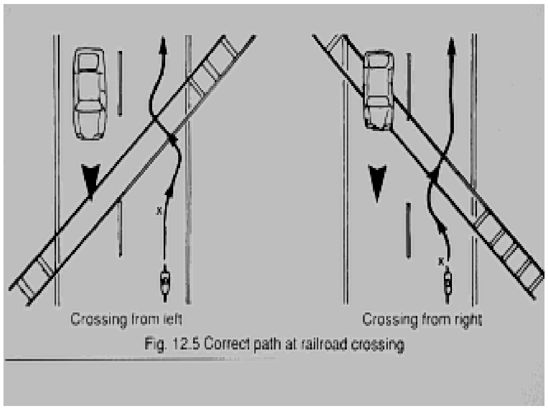
4.7.6.1 FDOT Rumble Strips

The FDOT Roadway and Traffic Design Standards (Standard Index) gives locations for rumble strips. The use of raised rumble strips restricted to the approaches to narrow bridges. The Department only permits the use of continuous rumble strips on limited access facilities.

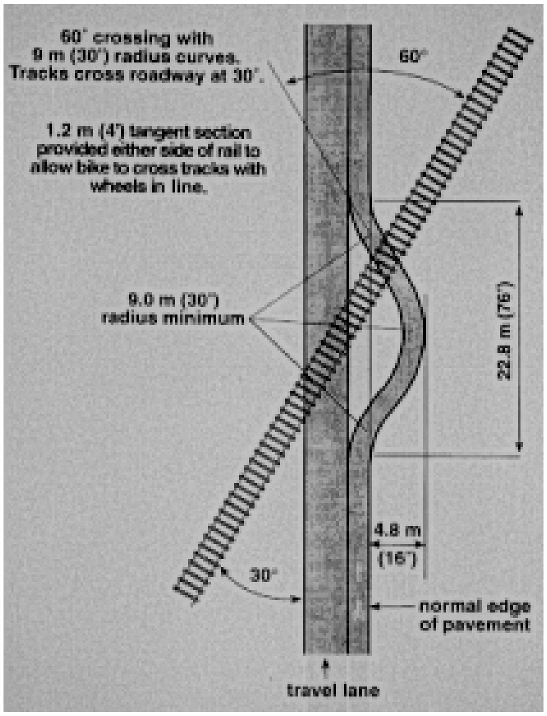
4.7.6.2 Other Applications of Rumble Strips

In other restricted applications, the shoulder should be widened to provide at least a 1.2 m (4 foot) riding surface. Rumble strips should be of a design that does not create instability to the bicyclist who inadvertently drifts onto one, especially under low light conditions. Designs other than those shown in the Standard Index sheets should be evaluated for their impact on bicyclists.

One treatment which has been suggested for use on busy two lane roads is the use of continuous ground in rumble strips. A test section in FDOT District 5 used 7" x 12" by 3/8" (175mm x 300mm x 10 mm) ground-in rumble strips adjacent to the edge line on existing 1.2 m (4-foot) paved shoulders. Since the 1-foot width uses up only the room needed for the handle bars overhang, there is no real



Bicycles at railroad crossings.
Above: Proper path for a cyclist across a railroad track. Below: Recommended treatment for less than 45 degrees angle crossing.


60° crossing with 9 m (30') radius curves. Tracks cross roadway at 30°.
60°
1.2 m (4') tangent section provided either side of rail to allow bike to cross tracks with wheels in line.
9.0 m (30') radius minimum
22.8 m (76')
4.8 m (16')
30°
normal edge of pavement
travel lane

infringement of the bicyclist space. The recent research report from the University of Maine by Professor Per Garder substantiates this, along with the benefits for ground-in rumble strips for bicyclists. A 6 mile (10 km) test section has been installed on a two-lane highway, SR 44, that has bicycle traffic. There have been no complaints to date. The 3/8"(10mm) depth was used because the asphalt on the shoulders is only 1" (25mm) thick per the plans, but is less in places. The audio response of vehicles on these 10mm rumble strips approximates that of the 1/2" (13mm) strips. Initial evaluations suggest these strips are safe for bicyclists. A detail of the rumble strips is included in Appendix E.

4.7.7 Bicycle Sharing Roadway Signing

Special guidelines have been issued (FDOT Traffic Engineering Manual) for the use of "Bicycle Sharing Roadway" signs. These signs are to inform motorists that bicyclists and motor vehicles are legally required to use/share travel lanes. These signs are generally used where safety problems or inappropriate motorist behavior indicate a need to remind users they are sharing the roadway with others. These signs may be appropriate for long narrow bridges in both urban and rural locations. Also, these signs can be used when a bike lane ends and the bicyclist is required to move into the roadway.

Designated bicycle facilities are not eligible for this sign. As a general rule, unless there is a special safety or road courtesy problem, corridors with paved shoulders or bike lanes will not be considered for this sign. As with any sign, overuse tends to breed disrespect for those cases where they are needed most.

Before issuing the signs, the district or community bicycle coordinator is asked to review the signing request.

4.7.8 Bicycle Routes

It may be advantageous to sign some urban and rural roadways as bicycle routes. When providing continuity to other bicycle facilities, a bicycle route can be relatively short. However, a bicycle route can be quite long. For longer bicycle routes, a standard bicycle route marker with a numerical designation in accordance with the MUTCD can be used in place of a bicycle route sign. The number may correspond to a parallel highway, indicating the route is a preferred alternate route for bicyclists.

It is often desirable to use supplemental plaques with bicycle route signs or markers to furnish additional information such as direction changes in the route and intermediate range distance and destination information. Bicycle route signing should not end at a barrier. Information directing the bicyclist around the barrier should be provided.

Overall, the decision whether to provide a bicycle route should be based on the advisability of encouraging bicycle use on a particular road instead of on parallel and adjacent highways. The roadway width, along with factors such as the volume, speed and types of traffic, parking conditions, grade and sight distance should be considered when determining the feasibility of bicycle routes. Recommended grades and sight distances are discussed in the Section 5.

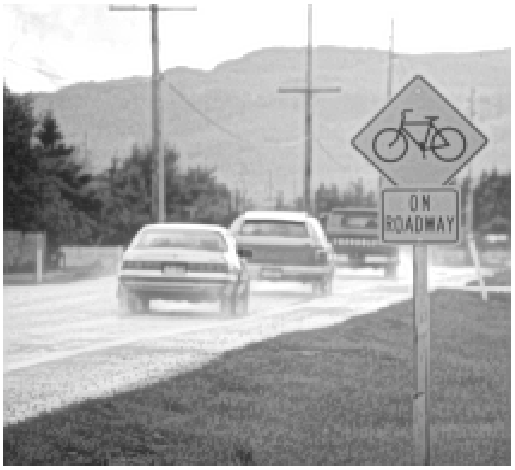
Generally, bicycle traffic cannot be diverted to a less direct alternate route unless the favorable factors outweigh the inconvenience to the bicyclist. Roadway improvements, such as adequate pavement width, drainage grates, railroad crossings, pavement smoothness, maintenance schedules and signals responsive to bicycles, should always be considered before a roadway is identified as a bicycle route. Further guidance on signing bicycle routes is provided in the MUTCD.

4.7.9 Bicycle Boulevards

In contrast to bicycle routes, bicycle boulevards offer more support to bicyclists by enhanced signing, traffic controls and connections. Bicycle boulevards serve as a primary route for bicyclists through a collection of lower speed side roads where traffic controls favor the through movement of bicyclists. Motorists attempting to use the same route for distance travel are thwarted through an occasional traffic diverter, a series of roundabouts, and other devices used to slow or rechannel motor vehicles. Boulevards may also have special trails, bridges or connections, offering the rider the most direct and quiet routing to primary destinations such as a downtown.

4.7.10 Special Neighborhood Bike Lane

Special bike lanes can be created on highly select local streets by restricting auto movement to one way, placing a low median divider of at least 70 inch (1.7 m) width, and with a 6 inch (150 mm) curb face on the motor vehicle traffic side. The bicycle side can have a zero curb height to allow additional maneuvering width. The created space can thus be dedicated for bidirectional bicycle travel. Such treatments call



Bikes Sharing Roadway Signing. *Above: This sign has been used in other states. Florida's sign uses the same symbol with the text "BICYCLE SHARING ROADWAY." Florida's procedure would not permit the use of the "BICYCLE SHARING ROADWAY" sign as shown above. In Florida the sign can only be used when cyclists are sharing the actual roadway. In this case the cyclists have a paved shoulder.*

Below: *This Canadian bike route sign serves as an important navigational aid, provides system continuity and reduces the potential for bicyclists to use roadways where they feel uncomfortable. Bike route signs are less effective when used without the navigational placard.*

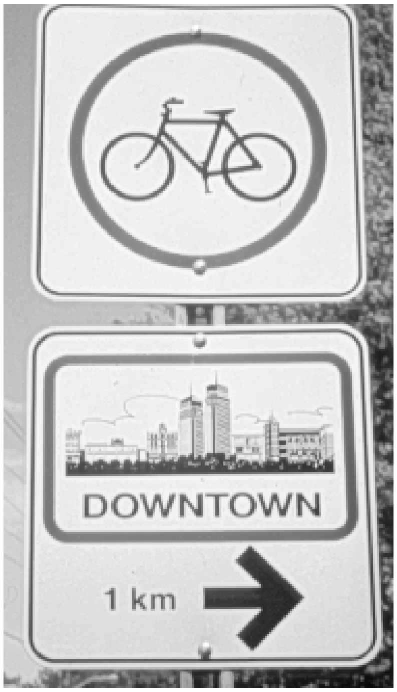
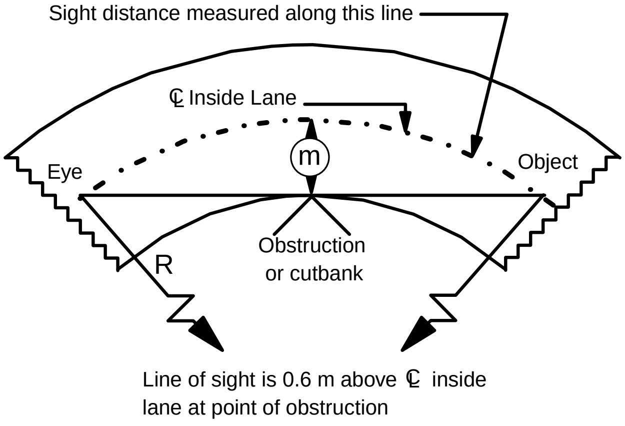


Table 3

Table 3 - Minimum Clearance for Horizontal
Given "R" and "S" : Find "m"


Sight distance measured along this line
℄ Inside Lane
m
Eye
Object
R
Obstruction or cutbank
Line of sight is 0.6 m above ℄ inside lane at point of obstruction

S = Sight distance in meters
R = Radus of ℄ inside lane in meters
m = Distance from ℄ inside lane in meters
S = Stopping sight distance in meters
V = Design speed for S in meters

$$m = R \left[1 - \cos\left(\frac{28.65\, S}{R} \right) \right]$$

$$S = \frac{R}{28.65} \left[\cos\left(\frac{R-m}{R} \right) \right]$$

Angle is in degrees
Formula applies only when S is equal to or less than the length of the curve.

Sight Distance

Radius of Centerline	10ft	20ft	30ft	40ft	50ft	60ft	70ft	80ft	90ft	100ft	110ft
25ft	0.50	1.97	4.37	7.58	11.49	15.94	20.75	25.73	30.68	35.41	39.72
50ft	0.25	1.00	2.23	3.95	6.12	8.73	11.76	15.17	18.92	22.99	27.32
75ft	0.17	0.67	1.50	2.65	4.13	5.92	8.02	10.42	13.10	16.06	19.28
100ft	0.12	0.50	1.12	1.99	3.11	4.47	6.06	7.90	9.96	12.24	14.75
125ft	0.10	0.40	0.90	1.60	2.49	3.58	4.87	6.35	8.01	9.87	11.91
150ft	0.08	0.33	0.75	1.33	2.08	2.99	4.07	5.30	6.70	8.26	9.97
175ft	0.07	0.29	0.64	1.14	1.78	2.57	3.49	4.55	5.75	7.10	8.57
200ft	0.06	0.25	0.56	1.00	1.56	2.25	3.06	3.99	5.04	6.22	7.52
225ft	0.06	0.22	0.50	0.89	1.39	2.00	2.72	3.55	4.49	5.53	6.69
250ft	0.05	0.20	0.45	0.80	1.25	1.80	2.45	3.19	4.04	4.98	6.03
275ft	0.05	0.18	0.41	0.73	1.14	1.63	2.22	2.90	3.67	4.53	5.48
300ft	0.04	0.17	0.37	0.67	1.04	1.50	2.04	2.66	3.37	4.16	5.03